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| **Data Analytics:** The course introduces data mining concepts and statistics/machine learning models and techniques for analyzing and discovering knowledge from large data sets that occur in engineering, particularly in manufacturing and production. The course presents data mining case studies that are drawn from production and manufacturing. | |
| * Introduction to Data Mining Process * Dimension Reduction * Evaluating Predictive Performance * Multiple Linear Regression * *k*-Nearest Neighbors * Naïve Bayes Classifier | * Classification and Regression Trees * Logistic Regression * Neural Networks * Discriminant Analysis * Association Rules & Collaborative Filtering * Cluster Analysis |
| **Data Visualization:** The course introduces students to static and interactive visualization charts and techniques that reveal information, patterns, interactions, and comparisons by paying attention to color encoding, shape selection, spatial layout, and annotation. It trains students for data exploration, knowledge discovery, storytelling, and decision-making in production and manufacturing. | |
| * Introduction to Data Visualization * Visualization Workflow * Data Representation for Visualization * Interactivity in Visualization * Annotation and Color for Visualization | * Composition in Visualization * Network Visualization * Text Visualization * Visualization Application of R and Python * Application of Tableau |
| **Algorithms and Optimization:** The course covers theory and algorithms of optimization with applications to manufacturing and production operations, with emphasis on design and analysis of efficient algorithms and data structures. The topics include modeling of discrete and continuous optimization problems graphs, network flow, divide and conquer methods, as well as greedy, approximate, randomized, and local search algorithms. | |
| * Optimization Models for Production Engineering * Linear Programming * Discrete Optimization * Fundamentals of Algorithm Analysis * Graphs and Network Flow | * Divide and Conquer * Greedy Algorithms * Approximation Algorithms * Randomized Algorithms * Local Search Algorithms |
| **Data Management for Analytics:** The course overs the theory and applications of database management to support data analytics, data mining, machine learning, and artificial intelligence. Presents a balanced theory-practice focus and covers relational databases, XML databases, NoSQL databases, data integration, data quality, data governance, big data, and data processing for analytics. | |
| * Database and Schema Design * Query Processing and Optimization * Object-Relational Databases, OLAP, SQL * XML Databases | * NoSQL Databases * Big Data * Data Integration, Quality, and Governance * Database in Mfg. IT Sys. (ERP, MES, CMMS) |
| **Sensor Analytics:** The course provides fundamentals diﬀerent types of sensors commonly used in production and manufacturing environment, and basic principles of operations of different sensors. The course also provides solid theoretical foundation for analyzing and processing experimental data in both discrete- and continuous time domains. | |
| * Basics of Sensor Systems; Sensor I/O; Actuators; Architectures * Motors; Encoders; Motor Control; Micro Controllers * Force, Torque, Tactile, Pressure, and Gas Sensors * Cameras and Optical Sensors (Machine Vision) * Time Signal Processing | * Intro to Real-Time Computation * Sampling and Reconstruction * Discrete Time Signal Processing * Spectral Analysis * Statistical Signal Processing * Noise Models and Filtering |
| **Cyber-Manufacturing Systems:** The course introduces students to the design and analysis of cyber-physical systems—computational systems that are integrated with physical processes. The course offers a holistic perspective of integrating control theory, sensors, perception, computer networks, and machine learning cyber-manufacturing systems. | |
| * Basic Modeling Concepts * Architectures (Design) * Sensors and Sensor Networks * Communication Protocols | * Cyber-Secured IoT * Networking and Communications * Supervisory Control and Data Acquisition (SCADA) * MTConnect, AutomationML, and OPC-UA |
| **Robotics & Automation:** This course introduces students to practice of robotics and automation systems in manufacturing. The course takes an interdisciplinary approach to cover the foundational topics in this field. Rather than the traditional bottom up approach, the course will introduce a systems and application centered methodology. Each module involves concepts and projects on fundamentals and practical aspects. | |
| * Systems and components * Current practices in R&A for manufacturing * Parts Handling and Bin Picking * Palletizing | * Cutting, grinding and dispensing * Collaborative Robots * Automated Ground Vehicles * Efficiency, Safety and Productivity |
| **Ethics, Privacy and Cybersecurity**: This is a 5-hour mandatory module designed to help learners become aware and mindful of ethics issues, privacy concerns, and cybersecurity risks involved accessing and using learning material in an online environment. | |
| * Ethics of using and sharing online learning material * Integrity of assessment in distance education | * Professional practices for privacy assurance * Measures to guard against cyberattacks |